TECHNICAL MANUAL

RESPIRATORY HUMIDIFIER MODEL

HC500

Revision C

March 1998

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Technical Manual for HC500 Respiratory Humidifier

Fisher & Paykel Healthcare have a policy of continued product improvement and reserve the right to alter specifications without notice.

Changes for Revision C

Description of change	Section
Performance test shortened	4.0
Maintenance procedure shortened	App. B

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1.0 HC500 Series General Specifications

1.1 HC500 Electrical Specifications

Supply Voltage:	230 ± 20 V 115 V 100 ± 10 V
Supply Frequency:	50 to 60 Hz
Supply Current (Heated wire mode):	0.8 A maximum at 230 V 1.5 A maximum at 115V
Supply Current (Non-Heated wire mode):	0.5 A maximum at 230 V 0.9 A maximum at 115 V
Heater Wire Capacity:	60 W
Water Heater:	85 W
Heaterplate Overheat Protector:	Operates at 118 ± 6 °C

1.2 Standards and Approvals

Designed to conform to the requirements of: UL2601-1, CSA-C22.2 No.601, IEC601-1, AS3200.1

Classification: Class 1

Type B

Drip Proof

Continuous Operation

Not to be used in the presence of flammable anaesthetics.

1.3 Temperature Control

PID (Proportional, Integral & Derivative) control of Heaterplate and Heater Wire.

1.3.1 Temperature Sensing

Temperature measurement using standard characteristic thermistors (YSI 400 compatible) mounted in fast response temperature probes, located at the patient end of the delivery tube and at the humidifying chamber outlet.

1.3.2 Temperature Display

Three digit, 14mm, 7 segment LED (Light Emitting Diode) display.

Range 5 to 80 °C. Below 5 °C displays 'Lo'. Above 80 °C displays 'Hi'.

Accuracy 25 to 45 ± 0.5 °C (tenths are not displayed unless in the service menu).

1.3.3 Set Point Temperature

Temperature selection by pointer knob on linear scale. See §1.4.1.

1.4 CONTROLS AND INDICATORS

1.4.1 ADJUSTABLE TEMPERATURE CONTROLS

- Heater Wire Mode.

  Selects airway controlling temperature. Adjustment is over a linear scale with resolution of 1 °C.

  The range depends on the offset temperature, selected by links on the control PCB (see §5.6).

Offset °C	Range °C
–1.0	32 to 39
–2.0	33 to 39
–3.0	34 to 39
–4.0	35 to 39

  To facilitate adjustment of the temperature control, when rotated, the actual setting is flashed on the 7 segment LED display. The display continues to flash for 5 seconds after control rotation has ceased.

  The Chamber temperature is controlled at a fixed offset from the airway temperature setting.

- Non Heater Wire Mode.

  Selects the HP (Heaterplate) controlling temperature. The range of adjustment is from 45 to 80 °C over a linear scale.

  Unlike the heated wire mode, the 7 segment LED display is not activated when the control knob is rotated. However the HP set temperature can be displayed by accessing the Service menu (see appendix A2).

  Note: An option available is to pre-adjust the set temperature and replace the normal control knob with a fixed knob. This will stop inadvertent adjustment of the set temperature.

1.4.2 INDICATOR LEDS

- Connectors alarm Red LED.

- Temperature alarm Red LED.

  Under the relevant alarm conditions these indicator LEDs will individually flash at a rate of 100 flashes per minute.

- See Manual alarm (Humidifier Failure) Red LED.

  This indicator, apart from flashing momentarily at turn on, will only be enabled if the watchdog circuit detects a microprocessor failure.

- Power On Green LED.

  Used to indicate power has been turned on to the humidifier.

- Heater Wire On LED.

  Used to indicate power has been turned on to the heater wire.

1.4.3 PUSH SWITCHES

- Mute Button.

  A momentary push will disable an audible alarm. The normal mute time delay is 3 minutes.

  Pressing the mute button for 1.5 seconds will cause the airway temperature to be displayed on the 7 segment display.

Using the mute button in conjunction with the Service button enables entry to the service menu.

On every initial push of the mute button, a momentary audio beep indicates function operation.

- Service Button.

  This is a hidden button used for accessing the service and calibration menu. Refer to appendices A1 and A2 for more information.

- Heater Wire Button.

  This toggles the HC500 into either a Heated Wire or Non Heated Wire mode. When this switch is latched in either operating position a single audio beep indicates successful latching. The 'ON' LED next to the button will light when this switch is latched.

  If a connector alarm immediately follows the operation of this button, this may be due to a heater wire being attached when switching to non heater wire mode or expecting one to be attached when switching from the non heated wire mode.

1.5 BASIC OPERATING MODES

1.5.1 HC500 IN HEATER WIRE MODE

The HC500 humidifier in Heated Wire mode incorporates a temperature controller, which monitors temperature at both ends of the delivery hose, by means of a dual temperature sensing probe assembly. In this way the Heaterplate and Heater Wire are regulated to maintain the desired temperature and humidity, within close limits, with a minimum of condensation.

The control knob sets the control temperature at the airway and the chamber outlet temperature is maintained at a fixed offset below this (the offset is link selectable, refer §5.6).

1.5.2 POWER UP SEQUENCE HEATER WIRE MODE

On power up the microprocessor watchdog is tested. The 'See Manual' LED will illuminate briefly if successful. All indicator LEDs (excluding the See Manual LED) are illuminated together with '8.8' on the digital display for two seconds. Then the Temperature Control setting is displayed for a further one second, followed by a single audible beep.

1.5.3 HC500 IN NON HEATER WIRE MODE

In the Non Heater Wire mode the *HC500* delivery temperature is maintained by Heaterplate control only. The sensor at the delivery end (airway end) monitors delivery temperature to prevent any rise above 41 °C. The sensor at the humidification chamber outlet is employed in a backup safety mode, to limit the chamber outlet to a maximum of 66 °C. In this way, safety at low flow rates (below 5 litre/minute) is improved at the expense of lowered flow performance.

The control knob sets the control temperature at the heaterplate, the maximum heaterplate temperature in this mode is 80 °C.

1.5.4 POWER UP SEQUENCE NON HEATER WIRE MODE

On power up the microprocessor watchdog is tested, the 'See Manual' LED will illuminate briefly if successful. All indicator LEDs are illuminated together with '8.8' on the digital display for two seconds, followed by a single audible beep.

2.1.5 POWER LINE INTERRUPT

A sample of the power supply frequency is derived from the power transformer secondary via R56 and Q1, buffered by Schmitt trigger U5f, and fed to the RST7.5 interrupt of U3. Resistor R68 pulls the secondary winding to ground when the diodes D13 to D16 are not conducting. The operating software determines the supply frequency facilitating the generation of a real time clock and also enabling a zero crossing detector for triac switching. The ADC is also phase synchronised with the line frequency thus eliminating any common error from this source.

2.1.6 41 °C COMPARATOR U10C

Operational amplifier U10c is a protection circuit to sense excessive delivery temperature rise. The non inverting input pin 5 is connected directly (via connector J4-1) to the airway thermistor. The inverting input goes to an adjustable divider network R33, VR4, R32. VR4 is set during calibration to ensure that the output pin 7 of U10c is low above an input temperature of 41 °C. This low output (OVHT) is fed via the isolating diode resistor networks D19, R55 and D20, R61 to clamp the bases of switching transistors Q10 and Q12. In this way, an airway temperature greater than 41 °C causes both heaters to be shut down.

A watchdog failure, which is a high output from U5g, is communicated via isolating diode D11 and resistor R31 to the non inverting input of U10c. This also ensures that both heater control circuits are clamped off in the event of a processor crash.

2.1.7 HEATERPLATE OVER TEMPERATURE

Thermistor HP senses the heaterplate temperature. Should the heaterplate exceed a preset maximum temperature during normal operation, power to the heaterplate is discontinued until it cools below this limiting temperature. Under certain operating conditions different maximum heaterplate temperatures can be selected. (See §5.6, Programming Control Options.) Also mounted on the heaterplate is a mechanical thermal cut out which will give protection should the electronic control system fail. This mechanical cut out is connected in series with the power transformer primary and thus causes complete shut down of the humidifier should a serious fault develop. The mechanical cut-out must be manually reset by means of the reset button located on the underside of the heaterplate module.

2.1.8 WATCH DOG U5B,G

During operation the processor is continually monitored for correct function. This is done by changing the state of output port PB7 of U4 every 16.6 or 20ms (power line frequency interrupt). This square wave buffered by U5b is fed to the charge pump circuitry C16, D4, D5 and C15, which ensures that pin 13 of U5g is held hard up. Should this square wave be interrupted for any reason, C15 will discharge through R3 giving a high output from pin 12, which drives the trap interrupt input of U3. This high trap input forces re-initialisation of the processor which may or may not be successful depending on the nature of the fault. The purpose of this is to ensure that if the processor should fail, and is unable to re-initialise, it fails in a safe mode. The watchdog circuit is tested every time the humidifier is turned on by deliberately halting program execution and waiting for initialisation via the watchdog. To indicate that the processor has failed, the high output of U5g also turns on Q3 which lights the humidifier fault LED10, and also turns off the display I.C U7 to blank the digital display.

2.2 POWER BOARD

A bridge rectifier (D13 to D16) supplies power to the 5 V regulator, Q7 mounted on the heat sink. This circuit is protected by a 1 Amp fuse (F1) mounted on the circuit board. The 5 V negative supply stabilised by Q8, is derived from the voltage doubling network D17, D18, C25.

The heaterplate is switched by a port pin, PC4, of U4 on the control board (HPC) and controls the optoisolator U12, which in turn switches triac Q11 (mounted on the heatsink). Resistors R57, R64 limit the gate current to the triac, and with C33, form a snubber network for both the triac and optoisolator.

The Heater Wire circuit (HHC) is controlled by triac Q9 which is mounted on the heat sink. Q9 is switched by the optoisolator U11 which in turn is driven by Q10. Q10 is controlled directly from an output port of U4 on the control board (HHC). R9 and C6 are a snubber network for the heater wire triac.

Heater wire sensing is performed by optoisolator U13 and associated components. Current is limited through the optoisolator's LED by R52 when triac Q9 is on and by R51 and R52 when the triac is off. Diode D21 protects U13 during the negative cycle of the 22Vac secondary. The output of the optoisolator (HHS) connects to U5d and then to U4. Resistor R67 prevents false triggering of the U13 phototransistor. The software can determine from the HHS signal whether a heater wire is connected or open circuit, and whether the heater wire fuse F2 is open circuit.

2.3 PROBE TEMPERATURE VERSUS THERMISTOR RESISTANCE

TEMP (± 0.5 °C)	RESISTANCE (Ohms)	TEMP (± 0.5 °C)	RESISTANCE (Ohms)
0	7352.8	36	1411.3
9	4702.2	37	1355.0
28	1976.6	38	1301.0
29	1893.3	39	1249.2
30	1814.4	40	1199.6
31	1739.2	41	1152.3
32	1667.2	42	1107.3
33	1598.2	43	1064.5
34	1532.9	44	1023.1
35	1470.6	60	560.3

3.0 CALIBRATION

Calibration is facilitated by entering a special Calibration mode (refer appendix A1). There are only two adjustments VR4 and VR5, the 41 °C comparator stage and setting the span of the A to D converter.

This calibration procedure may be carried out if the unit is thought to be out of calibration (E0x to E7x error messages in the display) or if any of the circuit boards have been replaced or repaired. In particular any repair that may have altered the potential of the ± 5 V rails or component change associated with the A to D converter would require a calibration check.

Calibration should be checked and performed after the unit has been running for at least half an hour; ie after the unit has warmed up.

3.1 EQUIPMENT REQUIRED

- 41 °C calibration probe, available in the F&P calibration kit (F&P part no. 900MR548).
- Small flat blade screwdriver.
- Large Pozidrive screwdriver.

3.2 CALIBRATION PROCEDURE

Note: For instructions on disassembly of the unit, refer to §5.0, Servicing Information.

1 Plug in the 41 °C calibration probe.

2 Gain access to the adjustment potentiometers VR4 and VR5, by removing the control board from the humidifier front panel.

3 With the Service button (SW3) held down turn on the mains power switch. The Temperature display should show '-1-'

4 Using the Service button (SW3) step to '-4-'

5 Starting with a vertical bar display adjust VR4 so the display changes to an all '8' display. If VR4 is rotated too far the display becomes all horizontal bars (||.||.||. through 8.8.8. to ===). The correct point is where all the segments of the all '8' display are of equal brightness.

6 Using the Service button (SW3) step to '-5-'

7 Remove the 41 °C calibration probe.

8 Adjust VR5 for a display reading of zero. (0) (Note this display reading may move by ± 2.0 over time.)

4.0 PERFORMANCE CHECK

These test procedures may be used to check the operation and calibration of the HC500 humidifiers without dismantling the unit. Performance is monitored during the test by using the functions of the Service Menu (refer appendix A2).

4.1 PERFORMANCE TEST: HEATER WIRE MODE

The heater base is run with fixed inputs to check for correct heaterplate and heater wire control.

4.1.1 EQUIPMENT REQUIRED

- Calibration kit (Part no 900MR548) containing 34.5 °C test probe and 41 °C calibration probe.
- A Fisher & Paykel recommended reusable heater wire assembly (eg 900MR510).
- Dual temperature probe assembly (eg 900MR560).
- Cup (250 ml) of hot water (> 41 °C).

4.1.2 TEST PROCEDURE

For this test only the HC500, test probe and heater wire are required.

1 Plug in a 34.5 °C test probe and connect the heater wire to the humidifier.

2 Turn the temperature control knob fully anticlockwise (minimum temperature).

3 Turn on the HC500 mains power switch.

4 Check the power on sequence:

i See manual light flashes briefly.

ii All LEDs and digital display illuminate for 2 seconds.

iii Display shows set temperature (either 32, 33, or 34) for 2 seconds.

(Note if the set temperature shows 35, it will need to be reset to 34 for the purposes of this test, see section 5.6.1 for how to reprogram this.)

iv Audio alarm beeps.

5 Push the heater wire button and check that the heater wire on light comes on.:

6 Enter the service menu (refer appendix A3) and check:

i	Temp control setting:	32 or 33 or 34 ± 0.1°C	(SET)
ii	Offset:	–1.0, –2.0, or –3.0 °C	(OFF)
iii	Airway temperature:	34.5 ± 0.2 °C	(Air)
iv	Chamber temperature:	34.5 ± 0.2 °C	(Ch)
v	Heaterplate maximum limit. *Record this*:		(hPL)

7 Run for at least 10 minutes without interruption.

8 After ten minutes :

i Heater wire cold (feel).

ii Heaterplate cold. (< 60 °C).

9 Turn the temperature control knob fully clockwise.

10 Enter the service menu (refer appendix A3) and check:

i Temp control setting: 39 °C (SET)

11 Run for at least 10 minutes without interruption.

12 After ten minutes:

i Check in the Service menu that the heaterplate temperature (hP) is approximately the same as the heaterplate maximum noted above (6v). Note the default setting is 100 °C.

ii Heater Wire hot (feel).

13 Disconnect the heater wire and check that the Connectors light flashes, and the audio alarm commences.

14 Press the MUTE button and check that the audio alarm is silenced.

15 Reconnect the heater wire and check that the Connectors LED stops flashing.

16 Disconnect the temperature probe and check again for the Connectors and audio alarms.

17 Reconnect the temperature probe and check that the Connectors alarm stops.

18 Place the airway probe end sensor into a cup of hot water (> 41 °C).

19 Check that the Temperature light flashes and the HC500 audio alarm begins. The temperature display should show the current airway temperature above 41 °C.

Note: The HC500 may indicate spurious 'EP4' or similar messages on the display. These can be ignored since they are due to the rapid change in temperature.

20 Remove the temperature probe from the cup and watch the temperature fall. When the temperature drops below 41 °C check that the Temperature light goes off and the Airway display goes blank.

21 Go straight to the non heater wire mode test.

4.2 PERFORMANCE TEST: NON HEATER WIRE MODE

This test checks that the heaterplate is controlled to the correct temperature, selected by the 'Temp Control' knob.

4.2.1 EQUIPMENT REQUIRED

- Calibration kit (Part no 900MR548) containing 34.5 °C test probe and 41 °C calibration probe
- A Fisher & Paykel dual temperature probe assembly, eg 900MR560.
- Fisher & Paykel humidification chamber (eg HC335) filled to the maximum water level.
- Cup (250 ml) of hot water (> 41 °C).

4.2.2 TEST PROCEDURE

(Ensure that the heater wire is turned off i.e.- heater ON LED is off)

1 Fill the chamber to the maximum water level and slide it onto the heaterplate.

2 Plug in the 34.5 °C test probe.

3 Turn the Temp Control knob fully clockwise. Enter the Service Menu and check:

i Temperature Control setting: 80.0 ± 0.2 °C (SET)

4 Run for a further 30 minutes, then check again the heaterplate temperature, it should now read 80 ± 1 °C.

This is the end of the performance check, record the test results on the maintenance chart , see appendix B2.

4.3 DUAL PROBE TEMPERATURE TEST

This test is recommended to be performed on temperature probes at least every six months, or if there is any doubt as to the accuracy of the temperature probe. This test allows the operator to compare the temperature readings of both probes (chamber and airway) firstly to one another, and secondly to a glass thermometer for absolute verification of temperature, if so desired. In the first case, assuming that both probes have not failed in a similar manner, any probes exhibiting a temperature difference of more than 0.7 °C would be suspect. In the second case, depending on the accuracy of the mercury in the glass thermometer any probes not agreeing within ± 1.5 °C of the thermometer reading would also be suspect.

4.3.1 EQUIPMENT REQUIRED

- Dual Temperature probe to be tested.
- Mercury filled glass thermometer.
- Cup (250 ml) of warm water (20 to 40 °C).
- Heater wire if using HC500 in heater wire mode.

4.3.2 TEST PROCEDURE

1 Plug the dual probe into the HC500 Humidifier. If in Heater Wire mode, ensure a heater wire assembly is connected.

2 Turn on the HC500 mains power.

3 Insert both temperature sensor probes into a container filled with water at a temperature between 20 and 40°C. As temperature gradients can be quite large it is recommended that the two probes be held together with a rubber band during this test.

4 Place the thermometer in the water alongside the probes and allow a minute for the temperatures to stabilise.

5 Enter the Service menu (refer appendix A2) and select 'CP' (compare probes) option. The display will alternate between the airway and chamber temperatures (chamber temperature is displayed with all decimal points showing).

6 Check the temperature difference between chamber and airway probes as indicated by the display. It should not exceed 0.7 °C.

7 Check that the chamber and airway probes read within 1.5 °C of the mercury thermometer.

5.0 SERVICING INFORMATION

This section provides information for servicing the HC500 Humidifier. The electronic circuitry is contained on two separate circuit boards, the power board and control board. In the event of a board developing a fault, it may be replaced by a new board. See §3 regarding calibration after repair.

5.1 PRINTED CIRCUIT BOARD REMOVAL

5.1.1 CONTROL PCB

The front panel and heaterplate assembly is separated from the humidifier body by removing the 4 fixing screws from the rear of the humidifier body. The front panel assembly can now be moved aside and the two ribbon cable connectors (J1 and J2) disconnected from the rear of the control board. If the front panel is now positioned face down the three plastic retaining latches protruding through the board can be moved in the appropriate direction to release the board. This is facilitated if a slight upward finger pressure is maintained on either edge of the board. When the latches release, the board will pop up leaving the push-on control knob behind in the front panel.

5.1.2 POWER PCB

Separate the case front from the humidifier body and disconnect the two ribbon cable connectors joining the Power PCB and Control PCB (J1 and J2). Cut the cable tie holding the heaterplate and chassis wires together.

The power board and heat sink assembly can now be removed by flexing the case sides away from the chamber edge of the board and moving the board forward slightly to disengage from the case. The board should now be lifted slightly to clear the lower retaining guides and moved further forward to gain access to the various wiring harness connectors which can now be detached. Before removing the PCB, unscrew the mains cord connections and cut the cable tie holding the mains cord in place.

5.2 HEATERPLATE

To reset the over temperature protector, separate the case front from the case body, then push the reset button (through a small hole under the heaterplate in the front panel case assembly).

To replace the heaterplate:

1 Separate the case front from the humidifier body.

2 Unclip the Power PCB from the case body (see §5.1.2).

3 Unplug the heaterplate wires from the Power PCB (connectors J3 and J7).

4 Unscrew the earth screw on the chassis for the heaterplate earth wire.

5 Unplug the ribbon cables from the Power PCB to the Control PCB (connectors J1 and J2). The front case assembly is now separate from the case body.

6 Detach the heaterplate from the case front by removing the three screws which secure it to the case front.

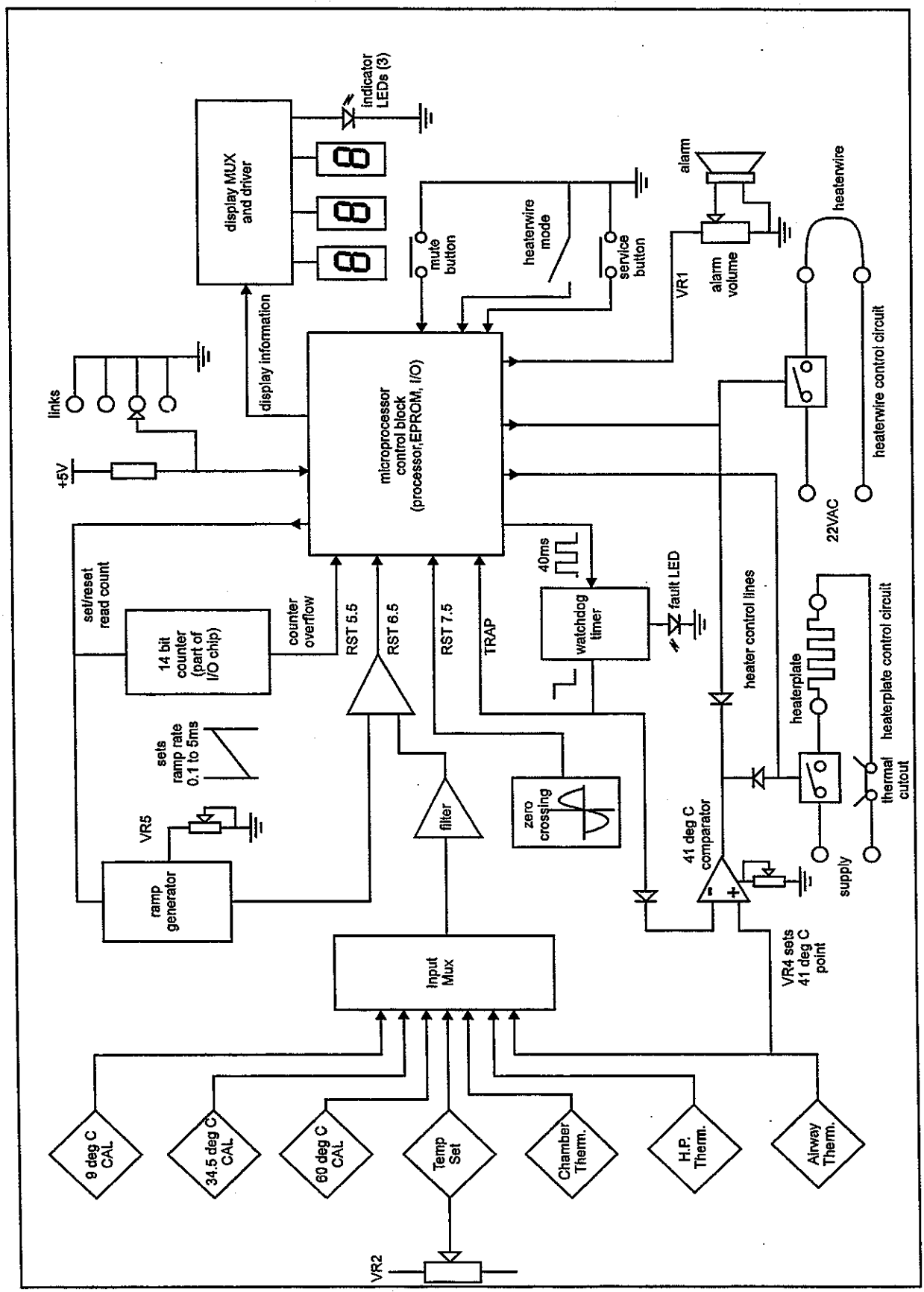
When replacing the heaterplate, ensure that the three springs are in place on the heaterplate fixing legs (check the heaterplate spring loading).

5.3 FAULT LOCATION

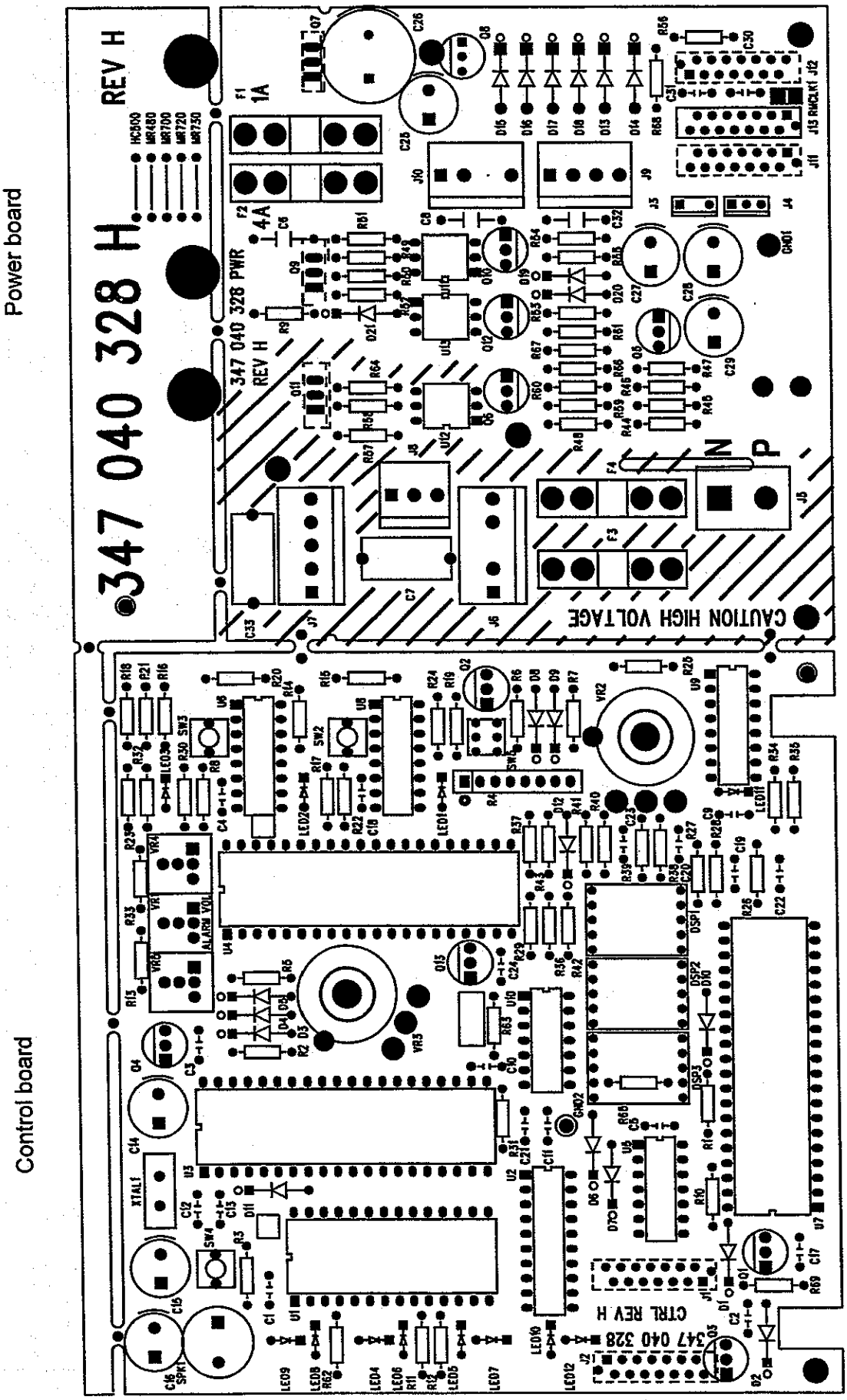
If neither the digital display nor any of the front panel LEDs are on and no power appears to be reaching the transformer primary, check that the mechanical overheat protector on the heaterplate has not cut out. This may be checked by depressing the red reset button (see §5.2).

Determine if all power supplies are operational and all fuses are intact. If the power supplies are OK but the display is blank, check the watchdog output (pin 12 U5g). A high output here will blank the display, turn on the humidifier fault LED indicator and isolate the heater circuits, but not necessarily stop the processor. Check for the presence of a 33 to 40 ms period square wave at PB7 (pin 1 U5b). If the watchdog output is high and the 33 to 40 ms clock is present a fault in the watchdog circuitry is indicated but if port PB7 is not changing state there is a fault elsewhere.

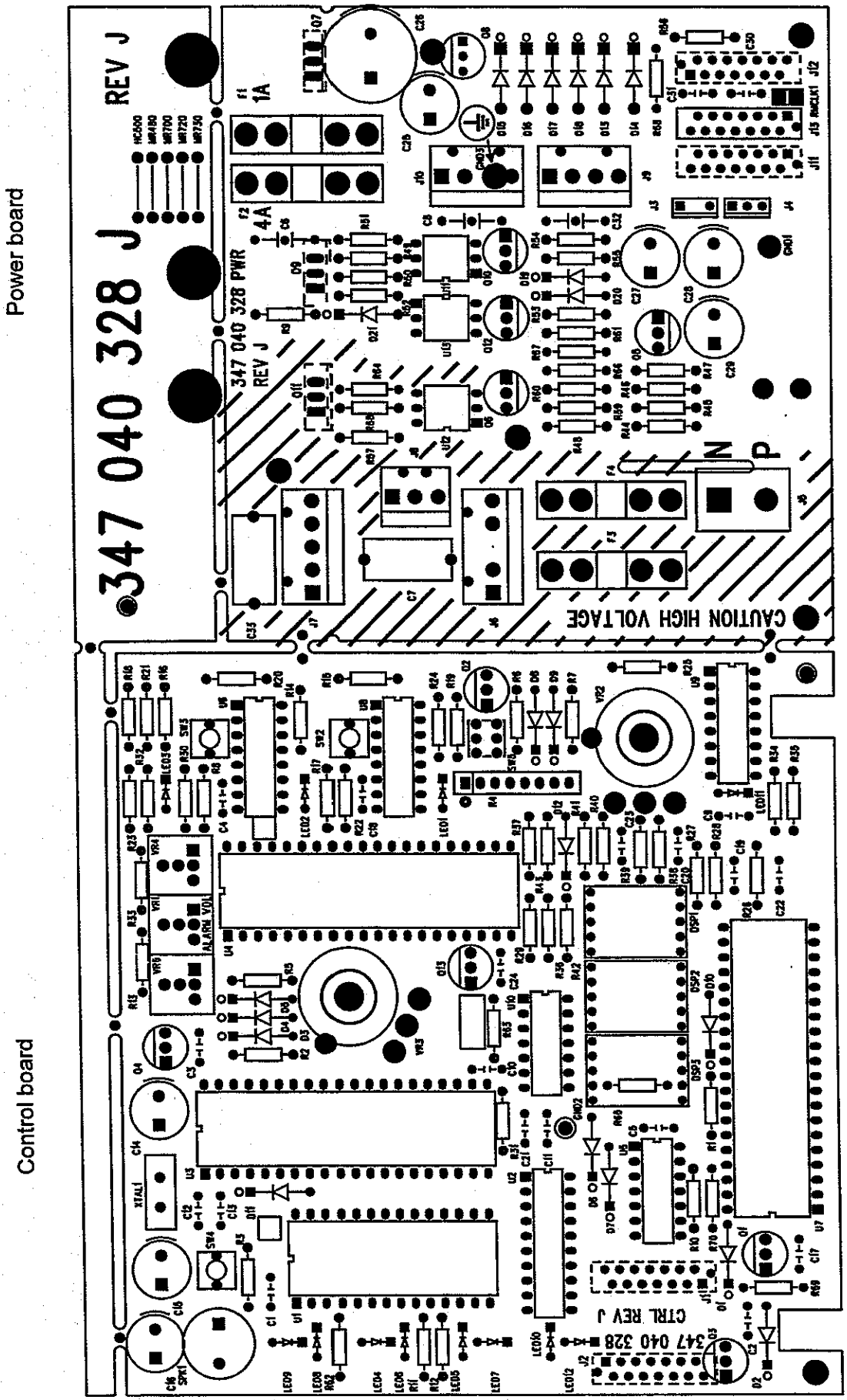
5.4 HC500 CIRCUIT LAYOUT BLOCK DIAGRAM



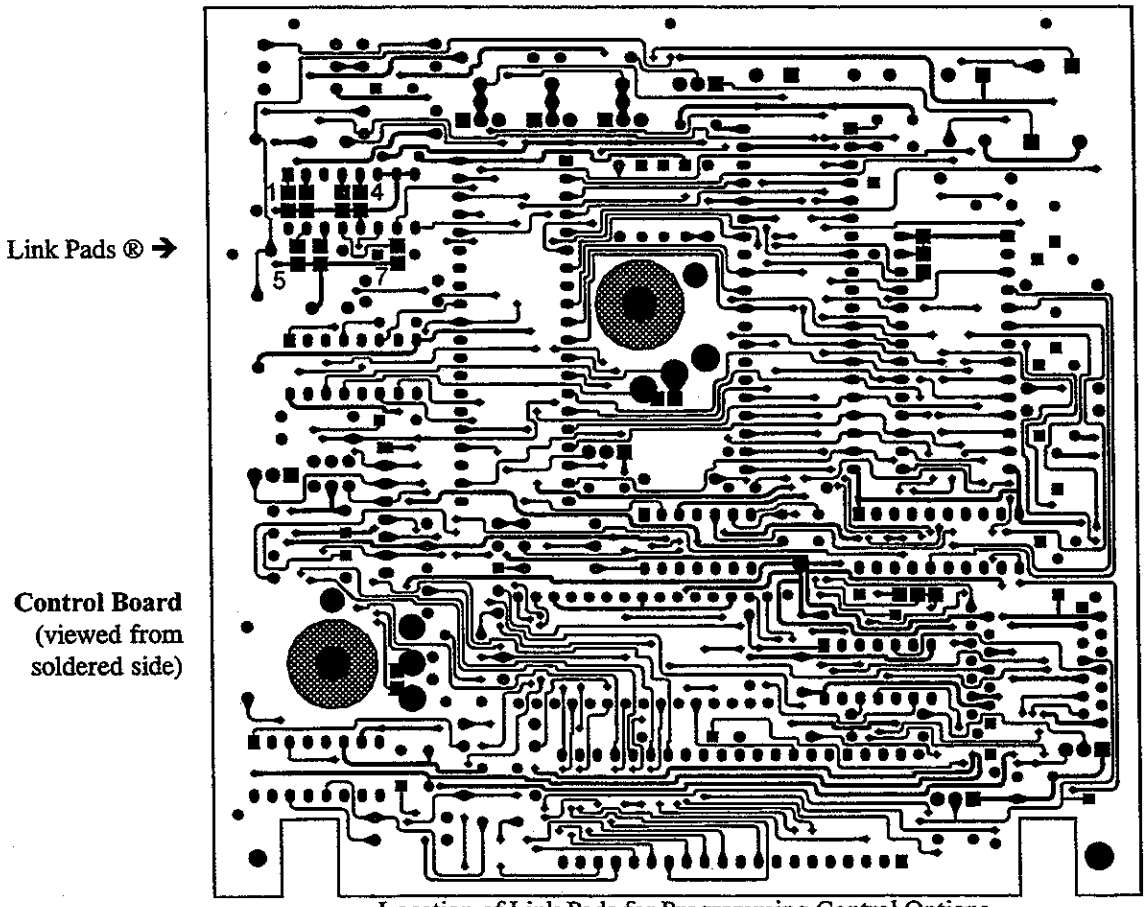
5.4 COMPONENT LAYOUT - REVISION H PCB



5.5 COMPONENT LAYOUT - REVISION J PCB



5.6 LINK PAD LOCATIONS FOR PROGRAMMING CONTROL OPTIONS - REVISION H AND J PCB



Location of Link Pads for Programming Control Options

5.6.1 PROGRAMMING CONTROL OPTIONS

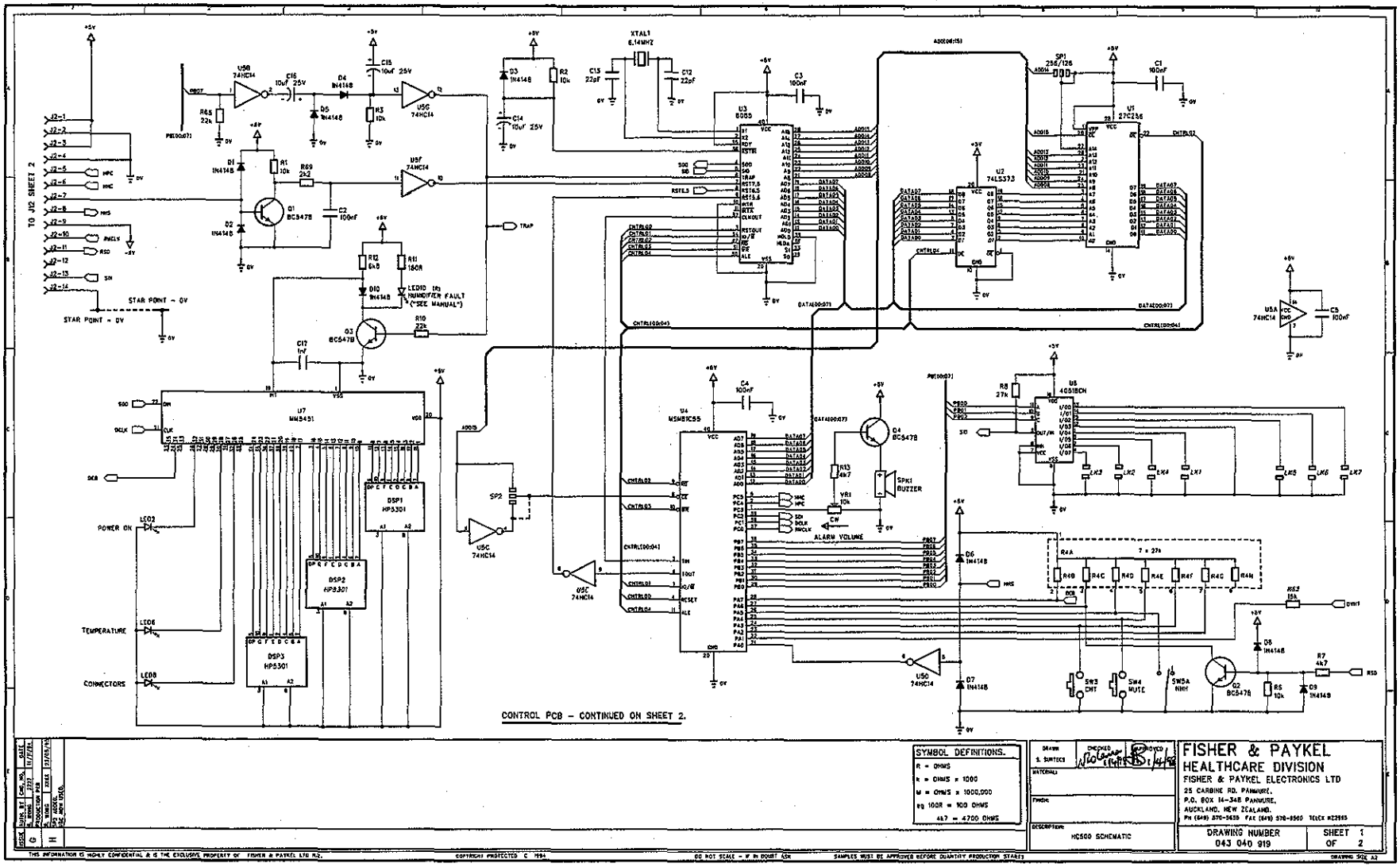
The following options can be enabled by joining the pads on the control PCB as shown in §5.6.

x = don't care.
1 = link.
0 = no link.

L1	L2	L3	L4	L5	L6	
1	0	x	x	x	x	50 °C maximum temperature Heaterplate.
1	1	x	x	x	x	80 °C maximum temperature Heaterplate.
0	1	x	x	x	x	90 °C maximum temperature Heaterplate.
0	0	x	x	x	x	100 °C maximum temperature Heaterplate (factory settng).
x	x	0	x	x	x	ISO draft standard audio alarm.
x	x	1	x	x	x	Gliding tone audio alarm.
x	x	x	x	1	1	–1.0 °C temperature offset.(32 to 39 °C range)
x	x	x	x	1	0	–2.0 °C temperature offset.(33 to 39 °C range)
x	x	x	x	0	0	–3.0 °C temperature offset (factory setting).(34 to 39 °C range)
x	x	x	x	0	1	–4.0 °C temperature offset.(35 to 39 °C range)

The factory default settings are for the 100 °C maximum heaterplate, ISO audio alarm and –3.0 °C temperature offset.

5.7 CIRCUIT DIAGRAMS - REVISION H CONTROL PCB


TO J12 SHEET 2
STAR POINT = 0V
CONTROL PCB – CONTINUED ON SHEET 2.
POWER ON
TEMPERATURE
CONNECTORS
ALARM VOLUME
SPK1 BUZZER
SYMBOL DEFINITIONS.
R = OHMS
k = OHMS x 1000
M = OHMS x 1000,000
eg 100R = 100 OHMS
4k7 = 4700 OHMS
FISHER & PAYKEL
HEALTHCARE DIVISION
FISHER & PAYKEL ELECTRONICS LTD
25 CARBINE RD. PANMURE.
P.O. BOX 14-348 PANMURE.
AUCKLAND. NEW ZEALAND.
PH (649) 570-3439 FAX (649) 570-3560 TELEX NZ2955
DRAWING NUMBER
043 040 919
SHEET 1
OF 2
HC500 SCHEMATIC
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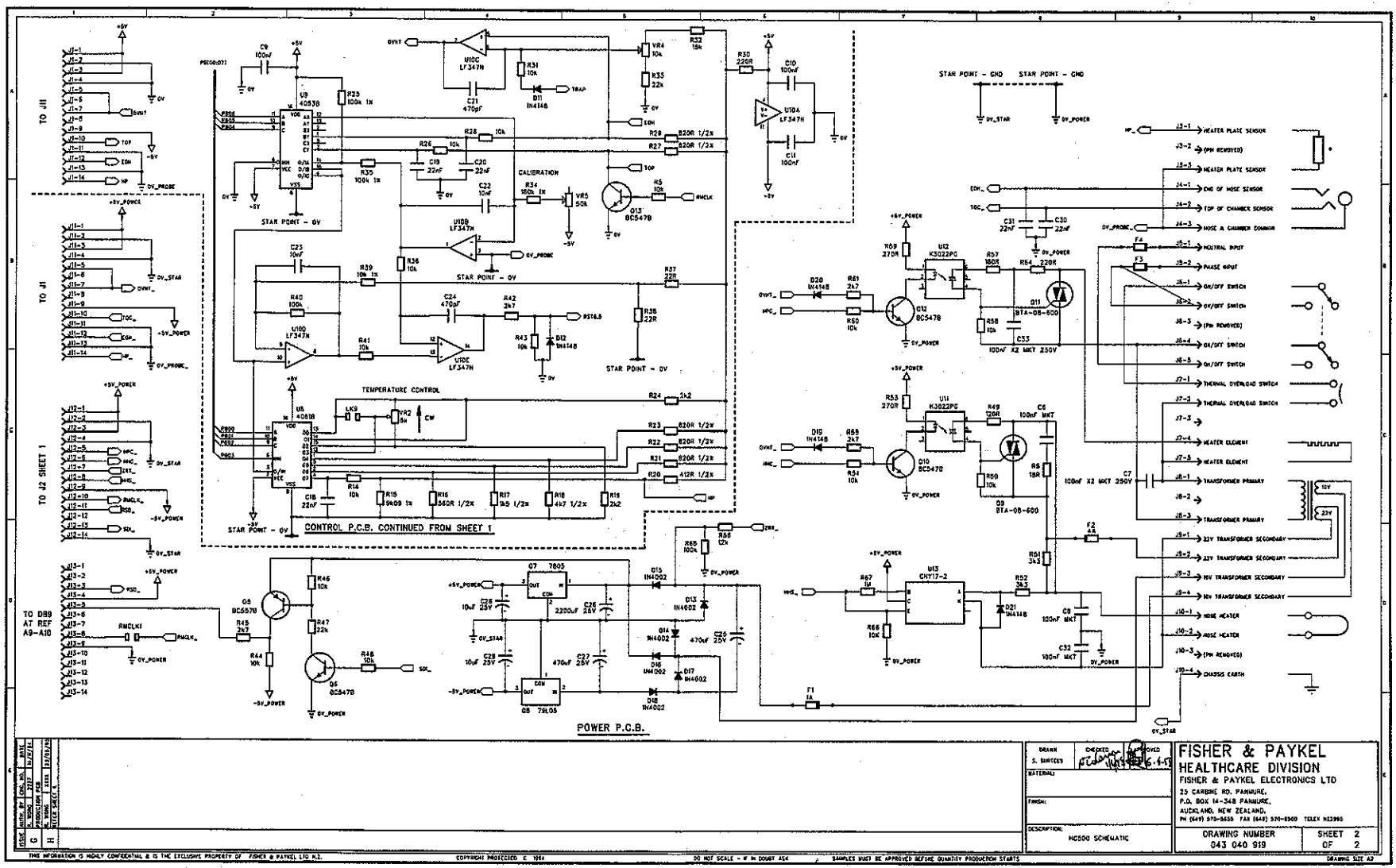
5.7 CIRCUIT DIAGRAMS - REVISION H POWER PCB



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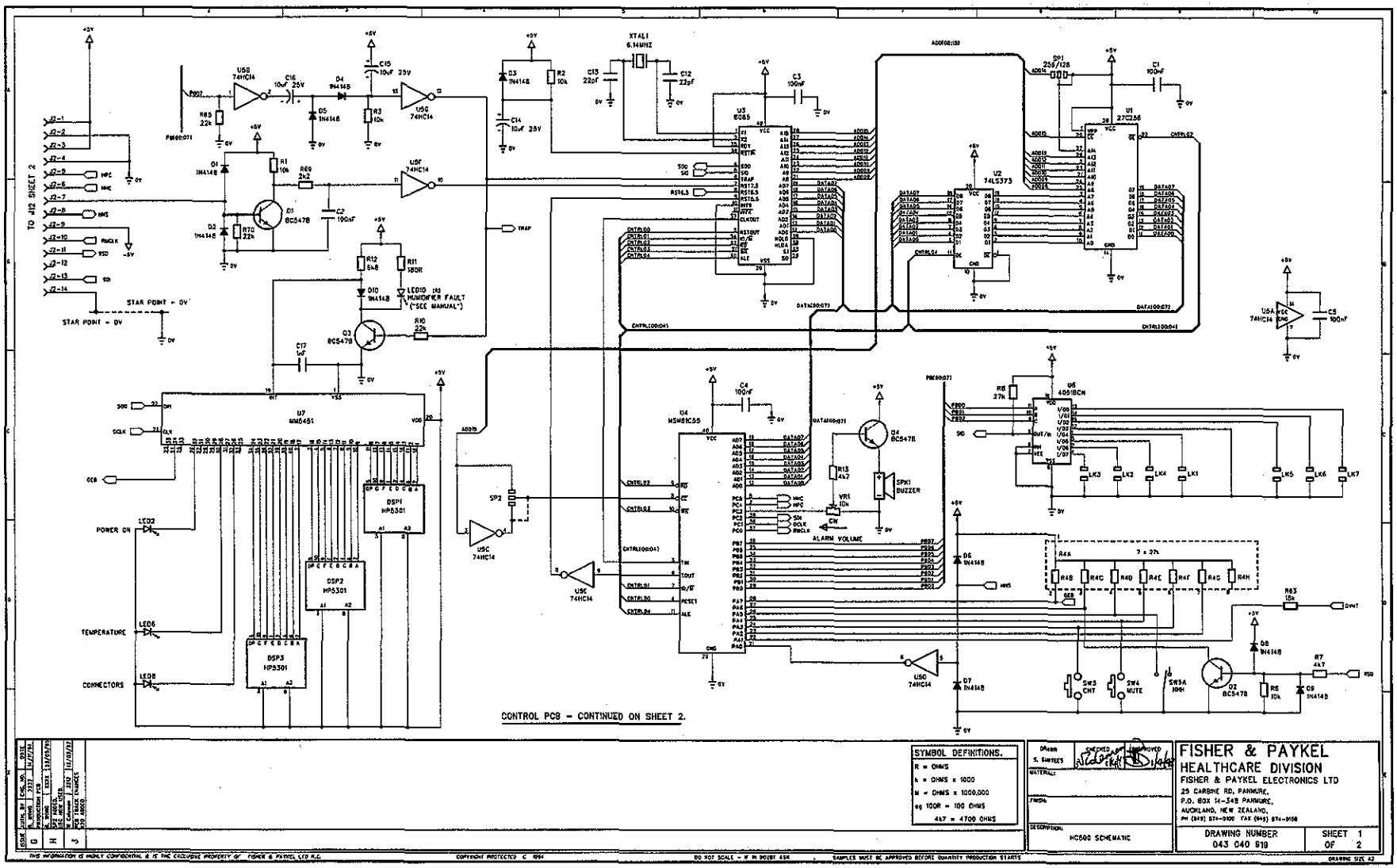
5.8 CIRCUIT DIAGRAMS - REVISION J CONTROL PCB


TO MB SHEET 2
STAR POINT = 0V
CONTROL PCB - CONTINUED ON SHEET 2.
POWER ON
TEMPERATURE
CONNECTORS
ALARM VOLUME
SPK1 BUZZER
SYMBOL DEFINITIONS.
R = OHMS
k = OHMS x 1000
M = OHMS x 1000,000
eg 100R = 100 OHMS
4k7 = 4700 OHMS
FISHER & PAYKEL
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25 CARBINE RD, PANMURE,
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SHEET 1 OF 2
HC500 SCHEMATIC
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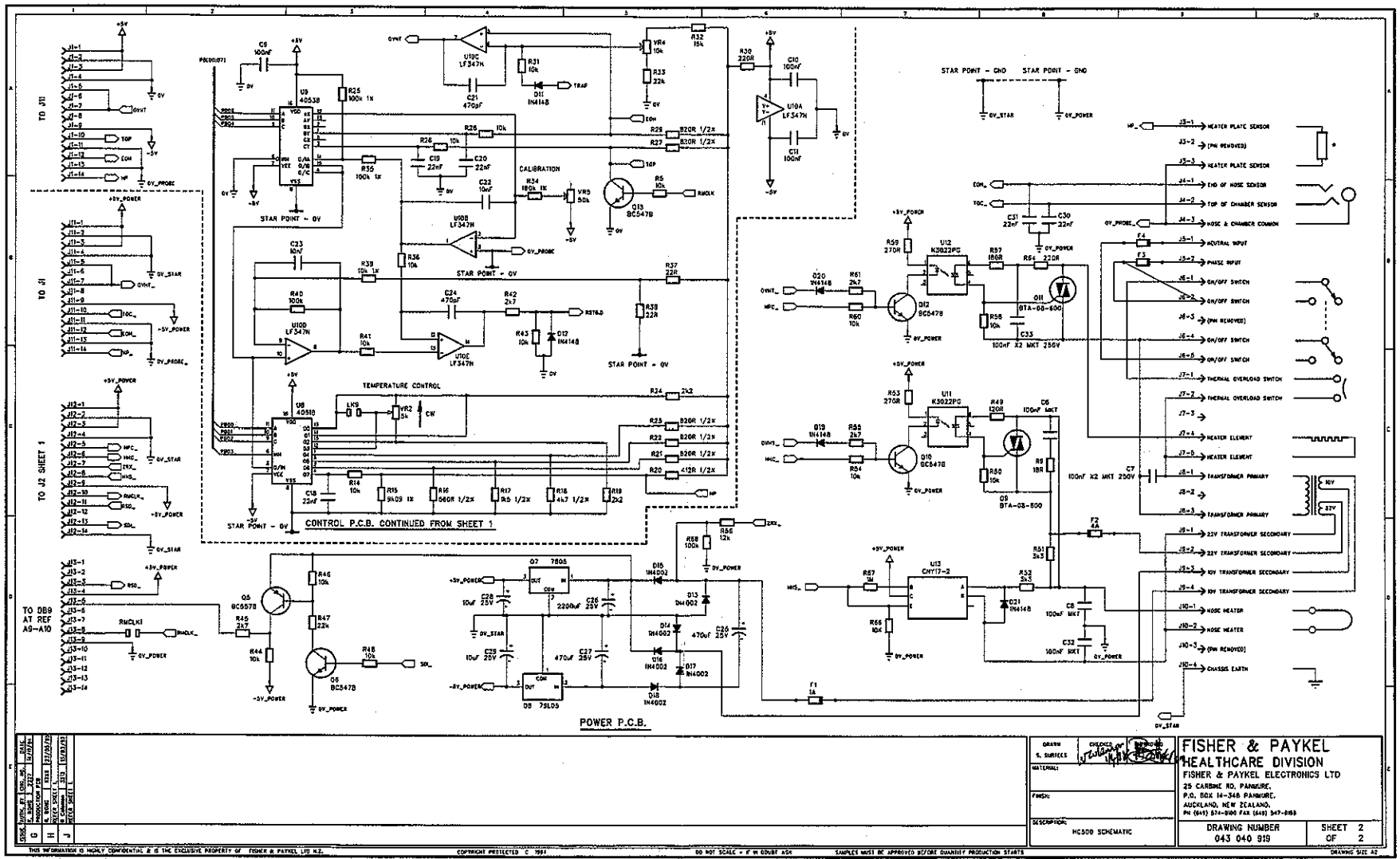
5.8 CIRCUIT DIAGRAMS - REVISION J POWER PCB



5.9 ELECTRICAL PARTS LIST

The electrical components listed below are referenced in accordance with the component layout and the circuit diagrams .

Note: The Control and Power PCB Assemblies listed below are parts for revision H and J PCBs.

5.9.1 CONTROL BOARD COMPONENTS

Reference	*Description*	*Part Number*
	PCB Upgrade kit-Control (Contains PCB, front fascia, operating manual and swing tag)	043040919
	PCB Assembly HC500 Control	043041056
	Eprom Programmed HC500 Version 1.0	362040084
C1, C3, C4, C5, C9, C10, C11	Cap. Ceramic 100 nF 50 V	312040153
C2	Cap. Mylar 100 nF 50 V	316040085
C12, C13	Cap. Ceramic 22 pF 50 V	312040130
C14, C15, C16	Cap. Elec. 10 µF 25 V	311040663
C17	Cap. Ceramic 1 nF 50 V	312040107
C18, C19, C20	Cap. Ceramic 22 nF 50 V	312040116
C22, C23	Cap. Mylar 10 nF 50 V	316040084
C21, C24	Cap. Ceramic 470 pF 50 V	312040118
D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11, D12	Diode 1N4148	361040155
DSP1, DSP2, DSP3	Display LED (HDSP5301 or LA6760)	999860001
J1A, J2A	14 pin ribbon connector socket	341040357
LED1,LED2	LED green	361040329
LED6, LED8, LED10	LED red	361040327
Q1, Q2, Q3, Q4, Q13	Transistor BC547B	361040159
R1, R2, R3, R5, R6, R14, R26, R28, R31, R36, R39, R41, R43	Resistor 10k 0.25 W 5%	325040284
R4	Resistor DIL Resistor pack 7/27k 5%	325046010
R7, R13	Resistor 4k7 0.25 W 5%	325040287
R8	Resistor 27k 0.25 W 5%	325040319
R10, R33, R65,R70	Resistor 22k 0.25 W 5%	325040318
R11	Resistor 180R 0.25 W 5%	325040309
R12	Resistor 6k8 0.25 W 5%	325040335
R15	Resistor 9k09 0.25 W 1% Metal Film	325040145
R16	Resistor 560R 0.25 W 0.5% Metal Film	325040135
R17	Resistor 1k5 0.25 W 0.5% Metal Film	325040137
R18	Resistor 4k7 0.25 W 0.5% Metal Film	325040138
R19, R24,R69	Resistor 2k2 0.25 W 5%	325040282
R20	Resistor 412R 0.25 W 0.5% Metal Film	325040152

R21, R22, R23, R27, R29	Resistor 820R 0.25 W 0.5% Metal Film	325040136
R25, R35, R40	Resistor 100k 0.25 W 1% Metal Film	325040139
R30	Resistor 220k 0.25 W 1% Metal Film	325040134
R32, R63	Resistor 15k 0.25 W 5%	325040317
R34	Resistor 180k 0.25 W 1% Metal Film	325040125
R37, R38	Resistor 22R 0.25 W 1% Metal Film	325040133
R42	Resistor 2k7 0.25 W 5%	999012720
SW3, SW4	Push switch	349040094
SW5	Heater Wire switch	349040099
SPK1	Audio Transducer CB-12KP	426040015
U2	IC Octal Latch 74LS373	999610004
U3	IC Micro-Processor 8085 A-Z	999630012
U4	IC Ram I/O Timer 81C55	363040415
U5	IC Hex inverter 74HC14	363040232
U6, U8	IC 8 Channel Mux. CD4051B	363040125
U7	IC Display Driver MM5451N	363040126
U9	IC 3×2 Channel Mux. CD4053B	999610003
U10	IC Quad Operation Amplifier TL074	363040124
VR1	10kPreset	327041561
VR2	5kPotentiometer	327041562
VR4	10k Preset Multiturn	327041565
VR5	50k Preset	327041563
XTAL1	Crystal 6.14 MHz	999820001
	Spacer Service Button PCB	693040701
	Spacer, Heater Wire Switch	693040522

5.9.2 POWER BOARD COMPONENTS

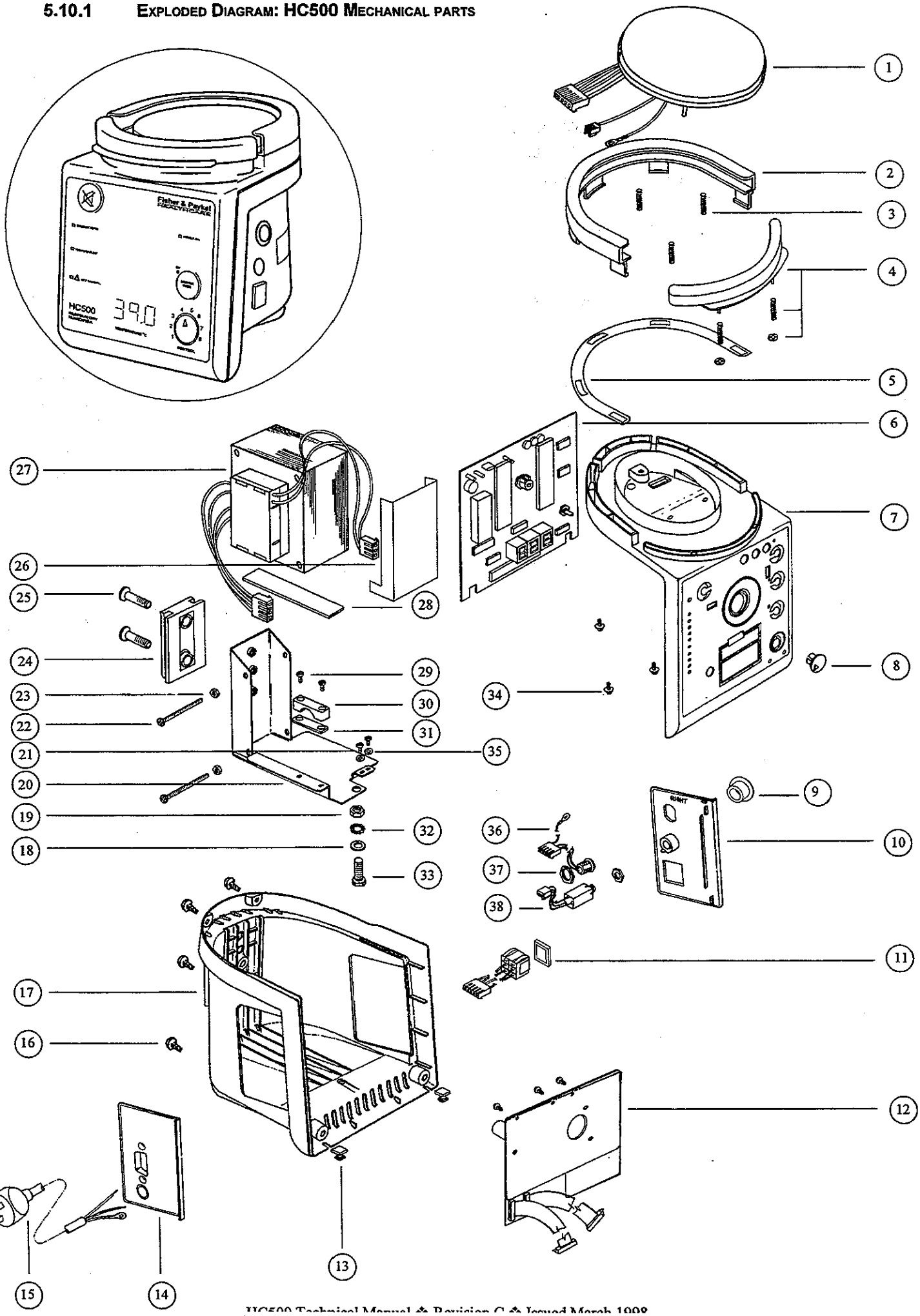
Reference	*Description*	*Part Number*
	PCB Assembly Power	043040637
C6, C8, C32	Cap. MKT. 100 nF 100 V	311040028
C7, C33	Cap. Poly 100 nF 250 V	316040073
C25, C27	Cap. Elec. 470 µF 25 V	999234710
C26	Cap. Elec. 1000 µF 25 V	999231020
C28, C29	Cap. Elec. 10 µF 25 V	311040663
C30, C31	Cap. Ceramic 22 nF 50 V	312040116
D13, D14, D15,D16, D17, D18	Diode 1N4002	361040163
D19, D20, D21	Diode 1N4148	361040155
F1	Fuse fast acting 1 Amp (20 × 5 mm)	999830001
F2	Fuse fast acting 4 Amp (20 × 5 mm)	999830017
F3, F4	Fuse fast acting 1.5 Amp (20 × 5 mm) for 230 V	999830008
F3, F4	Fuse fast acting 2 Amp (20 × 5 mm) for 115 V	999830009
Q6, Q10, Q12	Transistor BC547B	361040159
Q5	Transistor BC557B	361040156
Q7	IC 5 Volt Positive Regulator 7805	999600003
Q8	IC 5 Volt Negative Regulator 79L05	363040146
Q9, Q11	Triac Q4004L3 or BTA 08-600	999550011
U11, U12	IC Optocoupler MOC3022 MOC3023or K3022PG	367060001
U13	IC Optocoupler CNY17-2	363040045
R9	Resistor 18R 0.25 W 5%	325040366
R44, R46, R48, R50, R54, R58, R60, R64, R66	Resistor 10k 0.25 W 5%	325040284
R45, R55, R61	Resistor 2k7 0.25 W 5%	999012720
R47	Resistor 22k 0.25 W 5%	325040318
R49	Resistor 120R 0.25 W 5%	325046034
R53, R59	Resistor 270R 0.25 W 5%	325040294
R56	Resistor 12k 0.25 W 5%	325040289
R57	Resistor 180R 0.25 W 5%	325040309
R51, R52	Resistor 3k3 0.25 W5%	325040303
R64	Resistor 220R 0.25 W 5%	325040296
R67	Resistor 1M 0.25 W 5%	325052305
R68	Resistor 100k 0.25 W 5%	325040139
	Fuse clips	999840001

5.10 MECHANICAL PARTS LIST

Refer to the exploded diagram (§5.10.1).

Reference	*Description*	*Part Number*
1	Heaterplate Assembly 85 W 100 V	043040703
	Heaterplate Assembly 85 W 115 V	043040702
	Heaterplate Assembly 85 W 230 V	043040696
2	Chamber Clamp Kit Blank (includes Gasket Ref. 5)	043040829
	Chamber Clamp Kit French (includes Gasket Ref. 5)	043040830
	Chamber Clamp Kit German (includes Gasket Ref. 5)	043040831
	Chamber Clamp Kit English (includes Gasket Ref. 5)	043040834
3	Spring Mounting	662040040
4	Guard Chamber Kit	043040709
5	Gasket Clamp	336060126
6	PCB Assembly HC500 Control	043041056
6	PCB Assembly HC500 Control Upgrade Kit	043040919
7	Case Front Kit Specify: 'Case Front Kit HC500' and language (eg 'English/Spanish')	
8	Knob Offset	693040475
	Knob Fixed Offset	693040483
9	Probe Socket Cap	693041379
10	Case Door Right	693040473
11	Switch Harness Assembly	043040697
12	PCB Assembly HC500 Power Complete	043040637
13	Case Foot	693040478
14	Case Door Left	693040472
15	Mains Cord UL USA Hosp Grade	095428157
	Mains Cord Australian Clear Plug	095428159
	Mains Cord No Plug	095428160
	Mains Cord French 230 V No Plug	095428203
	Mains Cord Danish Plug 230 V	095428204
	Mains Cord UK Plug 230 V Fused	095428214
	Mains Cord Schuko Plug 230 V Shoelace	095428217
	Mains Cord Schuko Plug 230 V Earth Lug	095428226
16	Screw #8 × 1/2" Pan Phil TY25 S/S	614040120
17	Case Body Kit Specify: 'Case Body Kit HC500' and language (eg 'English')	
18	Washer M6 Wavy	622040140
19	Nut M6 Nyloc ZPS	621040524
20	Bracket Transformer	641040706
21	Screw M4 × 8 Pan Phil ZP Taptite	614040117
22	Screw M4 × 50 Pan Phil ZP	614040214
23	Nut M4 Nyloc ZPS	621040517
24	Bracket Mounting 30 mm × 5 mm Tongue	693040491
25	Screw M6 × 25 Csk Allen S/S	614040208
26	Insulator Transformer	331040158
27	Transformer Assembly 100 V	043040929
	Transformer Assembly 115 V	043040928
	Transformer Assembly 230 V (double insulated)	043040932
28	Tape Foam Adhesive 3 mm × 10 mm × 60 mm	254040059
29	Screw M4 × 14 Pan Phil Taptite YChr	614040223
30	Clamp Cord Small	693040476
	Clamp Cord Large	693040477
31	Insulator Mains Cord Clamp	336060064
32	Washer M6 Ext Fan Disk Lock Zn/St	622041013
33	Screw M6 × 16 Allen S/S Button Head	614040230
	Lug Earth	345060096
34	Screw M3 × 5 Taptite Pan Phil YChr	614040116
35	Washer Lock M4 Int Zn/Pl	622040130
36	Harness J10-Hose	095428271
37	Socket Heater Wire 4-Way	341040501
38	Probe Socket Harness Assembly	043040698

5.10.1 EXPLODED DIAGRAM: HC500 MECHANICAL PARTS

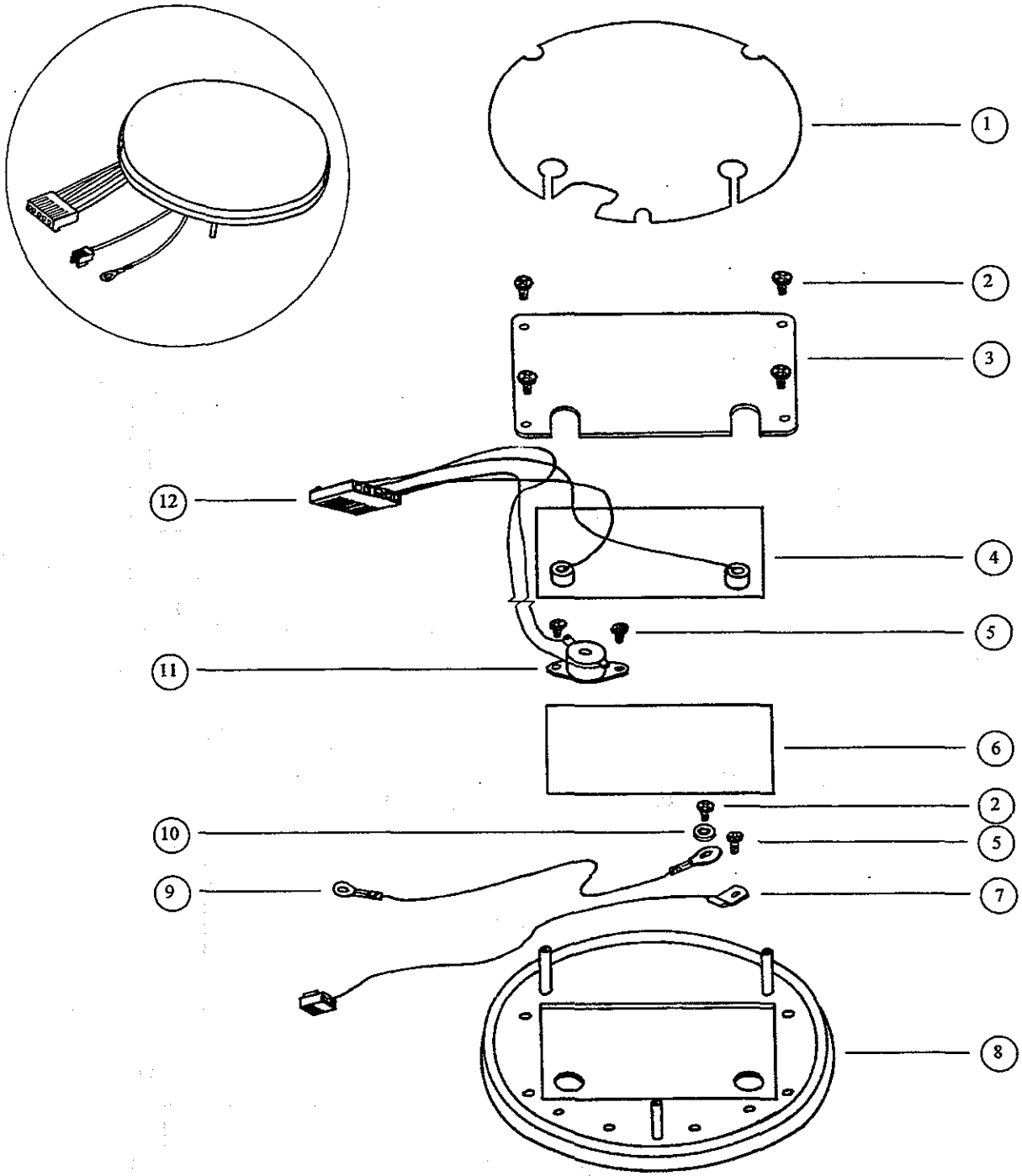


5.11 HEATERPLATE ASSEMBLY PARTS LIST

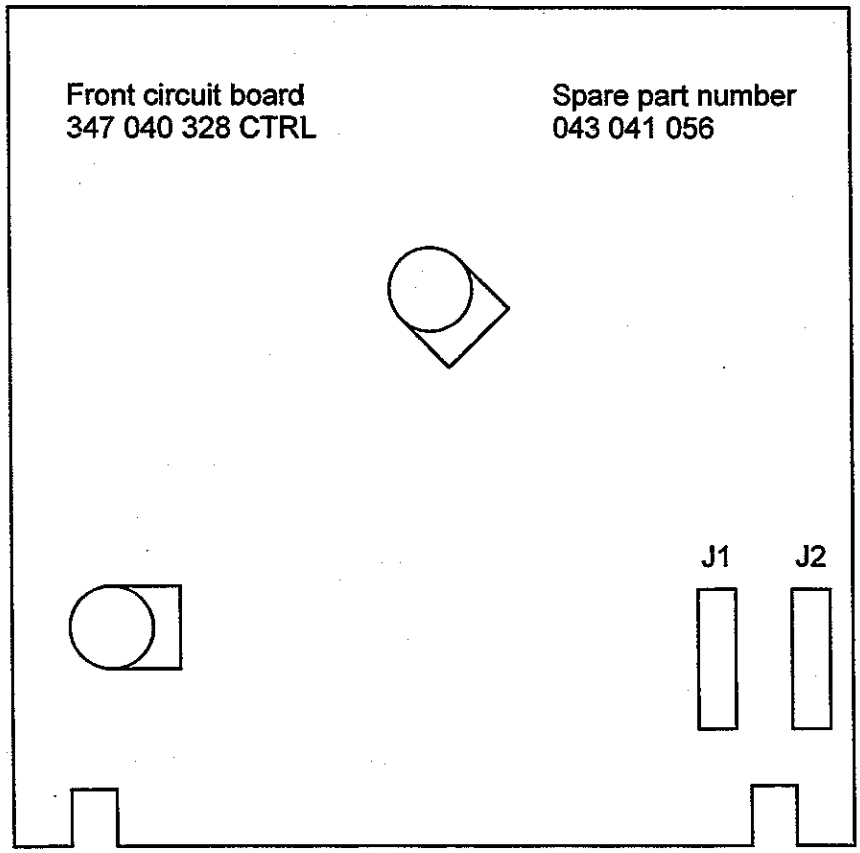
Refer to the exploded diagram (§5.11.1).

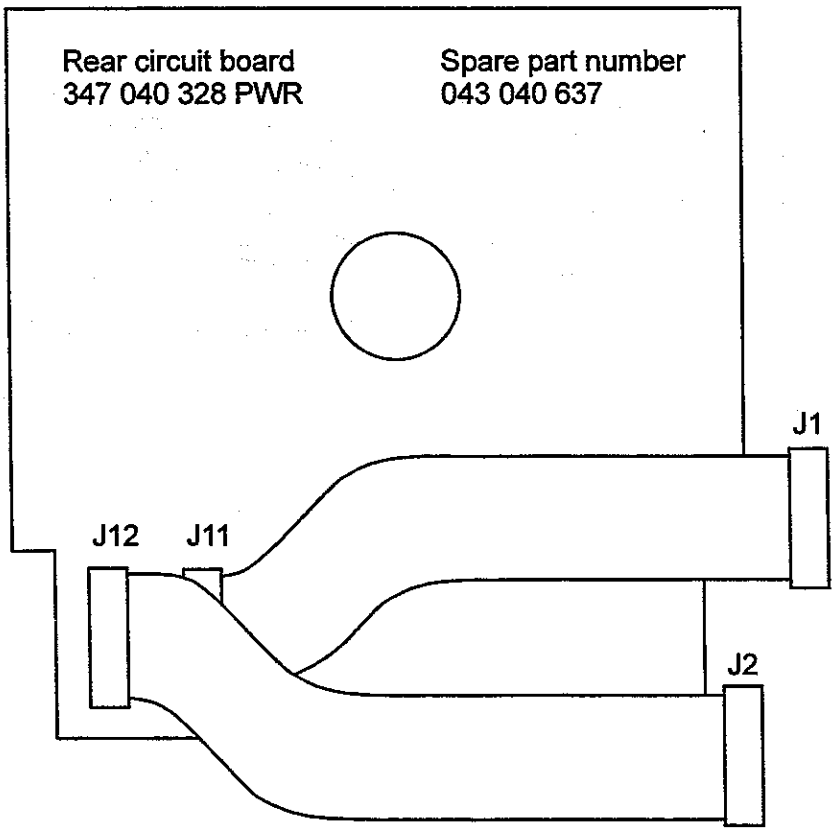
Reference	*Description*	*Part Number*
	Heaterplate 100V with element complete	043041231
	Heaterplate 115V with element complete	043041232
	Heaterplate 230V with element complete	043041233
1	Insulator Heaterplate	331040154
2	Screw M4 × 8 Pan Phil Taptite	614040117
3	Cover Element Plate	641040707
4	Element Assembly 100 V 85 W	043040898
	Element Assembly 115 V 85 W	043040897
	Element Assembly 230 V 85 W	043040896
5	Screw M3 × 5 Taptite Pan Phil YChr	614040116
6	Insulator Element	331040114
7	Thermistor and Harness Assembly	095428156
8	Heaterplate	043040875
9	Harness Heaterplate - Earth	095428154
10	Washer Lock M4 Int Zn/Pl	622040130
11	Thermostat 118 °C	349040052
12	Harness J7 - Heaterplate	095428279

5.11.1 Exploded Diagram: Heaterplate Assembly (Inverted View)

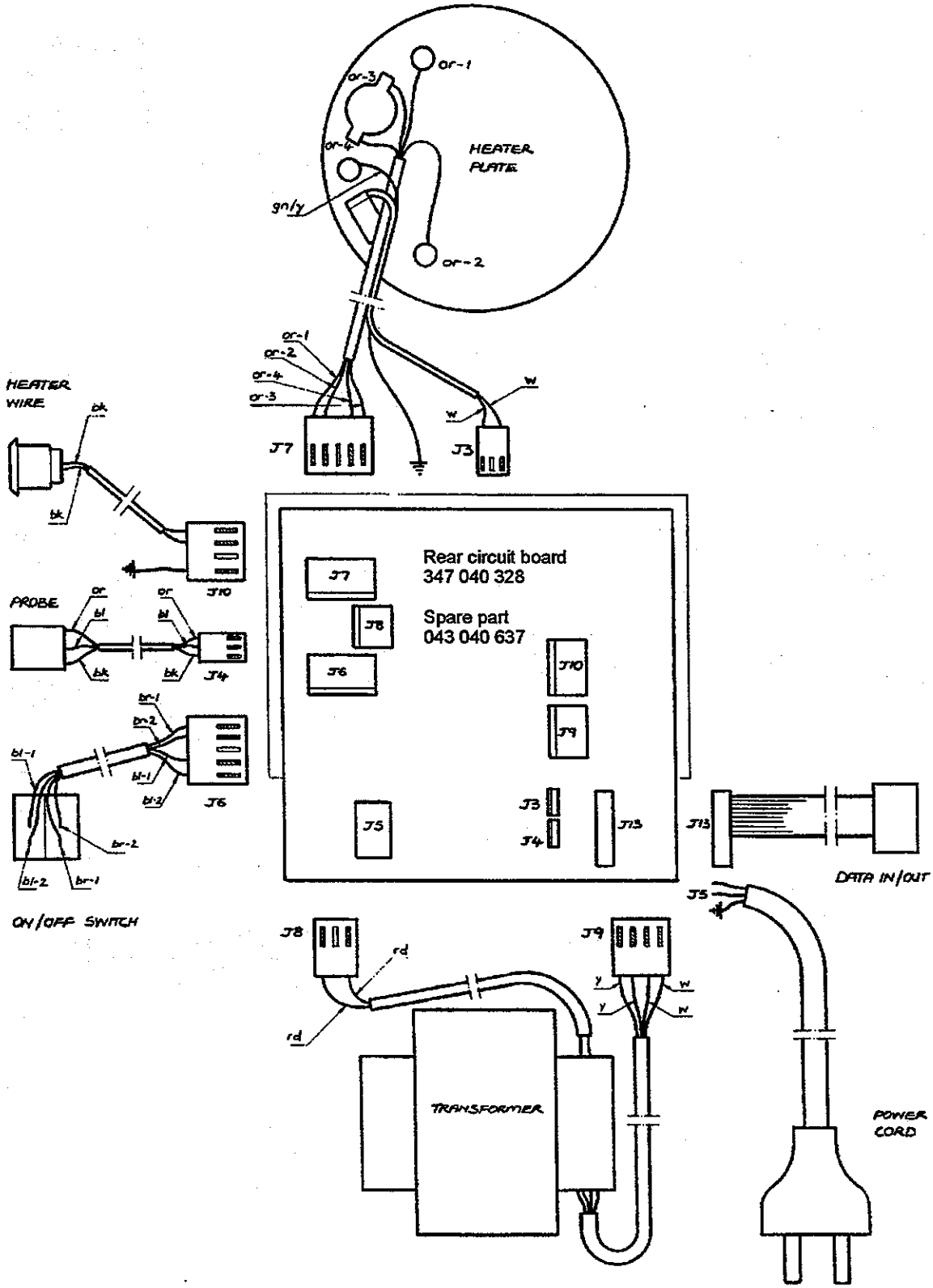


5.12 PCB IDENTIFICATION DIAGRAM





5.13 POWER PCB HARNESS CONNECTION DIAGRAM



6.0 PRODUCT CHANGE HISTORY

This change history details changes which may have significance for servicing. It does not include all changes. Refer also to change panel on circuit diagrams, and Appendices at back of this manual.

DATE	CHANGE NUMBER	FIRST SERIAL NUMBER AFFECTED	COMMENTS
30/1/97	3136	9650xxx13223	Heater wire ON/OFF button added to front fascia.
1/4/97	3230	9750xxx6683	Change PCB to revision J

6.1 MODEL NUMBER EXPLANATION

eg for HC500AEU:

HC500	A (first letter)	E (second letter)	U (third letter)
Model Type	Voltage	Language	Customer Specific

The first and second letters represent the following:

First Letter	Voltage	Second Letter	Front Panel Language	Side Panels Language
A	230 ± 20 V	D	English	English/German
J	115 V	E	English	English/French
G	100 ± 10 V	F	French	English/French
		G	German	English/German
		H	English	English/Spanish
		J	Japanese	English/Japanese
		L	Italian	English/Italian
		S	Spanish	English/Spanish

6.2 SERIAL NUMBER EXPLANATION

eg for 9650AEU09462:

Year	Model Number Abbreviation	Code	Serial Number
96	50	AEU	09462

The three-letter code (eg AEU) is defined above.

APPENDIX A MISCELLANEOUSP

A1 CALIBRATION MODE

Note: Calibration should be checked and performed after the unit has been running for at least half an hour, ie after the unit has warmed up, particularly for the ADC zero calibration.

Entry to the calibration mode is made by holding down the Service button (refer figure A1) and turning on the Mains Power switch.

After a two second delay the display should show '-1-'.

On releasing the Service button the display will show the humidifier model number (500).

The Service button is now used to step between functions as shown below.

-1- Model number display.

-2- Software version display.

-3- Traceability number.

-4- 41.0 °C comparator calibrate. VR4

-5- ADC zero calibrate. VR5

On pushing the Service button the display will show the present function number then after a one second delay step to the next higher function number, where if the Service button is then released will enter that function.

To carry out the 41.0 °C comparator calibration (test 4) a 41.0 °C calibration probe must be plugged into the humidifier. The 41.0 °C calibration point is where the display just changes from ||||| to ═══ while slowly turning VR4, or from ||.||.||. to an all 8.8.8. display with all segments of equal brightness.

During the ADC zero calibration (test 5) no probe should be connected to the humidifier. Adjust the ADC zero calibrate control VR5 for a display reading of '0'. Note that negative calibration numbers are shown with all decimal points on.

The calibration mode will time out (to normal operating mode) 5 minutes after the last Service button push. The normal exit mode is to turn the humidifier heater base mains power switch off then on again.

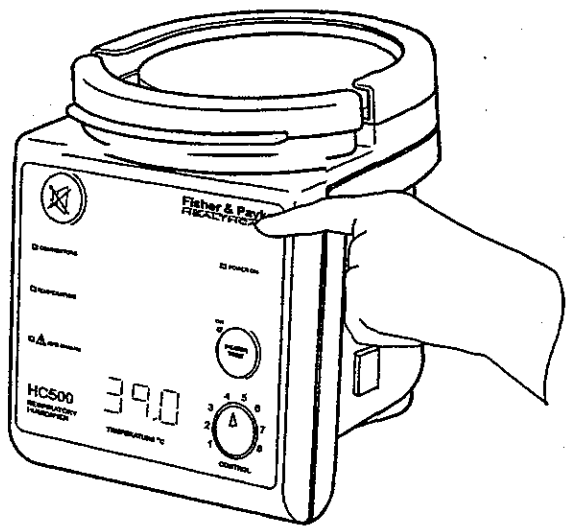


Figure A1. Hidden Position of the service button.

A2 SERVICE MENU

To enter the service menu push the Mute and the Service buttons simultaneously (for position of service button refer to figure A1) and hold for at least 1.5 seconds. At this time the display will show SET (for set temperature display) as a pointer to that function and on release of the Service button the display will show the set temperature control temperature setting to one decimal place.

To maintain this display, the Mute button should be kept depressed. If the Mute is released, the display will revert to normal operation in approximately 6 seconds.

The display can be stepped through the service menu in two ways.

If the Mute is held down constantly the functions can be selected sequentially by momentarily holding down the Service button until the display changes to the next function pointer, where if the Service button is then released the display will show that function.

Alternately using only the Mute button if the Mute is momentarily released the display will flash up with the current pointer to that function and after a second delay will advance to the next pointer indication where the Mute can be pushed to enter that function or allowed to advance to the next pointer.

Approximately every 6 seconds the word 'End' will flash in the display where if no action is taken the display will revert to normal operation. However if the Mute is momentarily pushed synchronously with this 'End' message, the time out will be inhibited and the stepping through the function pointers continued.

A3 SERVICE DISPLAY FUNCTIONS

SET	Set temperature display.
OFF	Chamber temperature offset display.
Air	Airway temperature delivered to the patient.
Ch	Chamber outlet temperature.
hP	Heaterplate temperature.
hPL	Heaterplate maximum temperature limit.
Edc	Heater wire duty cycle.
Hdc	Heaterplate duty cycle.
CP	Compare probes (Probe test).
Ei	Heater wire integral.
Ti	Heaterplate integral.

In the non Heater Wire mode of operation only the functions shown below are enabled.

SET	Set temperature display.
Air	Airway temperature delivered to the patient.
Ch	Chamber outlet temperature.
P	Heaterplate temperature.
Hdc	Heaterplate duty cycle.
CP	Compare probes (Probe test).
Hi	Heaterplate integral.

The integral is an error offset signal which constantly accrues to compensate for the temperature difference between the set control and sensor. It is displayed in the 'Ei' , 'Ti' and 'Hi' service functions in hexadecimal notation. A negative integral is indicated by the three 'decimal points' in the display being lit. The hexadecimal value of the integral is ± EFF (± 3839 in decimal).

A4 GLOSSARY OF ABBREVIATIONS

ADC	Analogue to Digital Converter.
EOH	The End Of Hose temperature or airway temperature.
EMI	Electromagnetic Interferance.
OFFSET	The temperature difference of the chamber from the SET.
SET	The temperature Set potentiometer.
TOP	The temperature at the humidification chamber outlet or chamber temperature.
HP	The Heaterplate temperature.

A5 ERROR CODES

During operation if the microprocessor U3 does not receive an expected interrupt within a given time window an error condition will be flagged. In particular the RST6.5 interrupt which marks the termination of the integration ramp from U10-E and also controls the counter in U4 will in the event of the count exceeding certain limits generate an error message. When the count recorded by U4 is less than 256 an underflow error is generated and should the count exceed 16128 an overflow error is indicated.

Some of the error indications which can be displayed on the HC500 digital display are listed below, with an explanation of the possible cause.

A5.1 ERROR MESSAGES

Ec	Checksum error (possible failure of U1 EPROM).
En	Memory test error (possible failure of U4 RAM).
EXx	Where X = 0 through 7, indicating multiplexer stage where error occurred. Where x = o or u, indicating ADC overflow error or underflow error, at the indicated multiplexer stage.
b-1	The Mute button is on at turn on or has been on for more than 5 minutes.
b-2	SW2 short circuit (see b-1 above)
F-2	The Heater Wire fuse F2 is open circuited.
---	Temperature sensor probe fault (see §1.6.2).

The following errors may occur during the software-driven shorted probe cable test. If the errors do not persist they do not necessarily indicate a faulty probe assembly. It is because of conflicting results during the test that a definite conclusion cannot immediately be made.

Errors EP2 to EP4 can be caused for example by abnormal high differential temperatures on the two thermistors or by rapidly changing input temperatures.

EP1	Hardware fault; Q13 short not effective.
EP2	Low probe temperature (~ 0 °C).
EP3	High probe temperature (~ 70 °C).
EP4	Partial short between the active probe cable conductors.

APPENDIX B MAINTENANCE SCHEDULE

B1 RECOMMENDED MAINTENANCE SCHEDULE

The HC500 series humidifiers operating software continually monitors the performance characteristics of the heater base reporting any errors and in the event of a fatal error terminates operation in a fail safe mode. For this reason preventative maintenance of the humidifier need only be performed at extended intervals.

The following list of routine checks are recommended to be performed at the intervals stated.

Six Monthly

1 Check all external cables and connections as described below.

2 Perform a temperature probe test as outlined in §4.3. Also check for damage to sensor tips, abrasion of the cable or tarnishing of electrical contacts. Clean with alcohol on a cloth or replace as necessary.

3 Remove and check the reusable heater wire (if fitted) for kinks and abrasions. Replace if necessary.

4 Check heater wire connector for damage to cable and both end plugs. Check for correct coupling of the plugs with their respective sockets on the heater base and heater wire assembly.

5 Check humidifier power cable for damage or corrosion and replace as necessary.

6 Plug the temperature probe and heater wire (if fitted) into the humidifier and switch on. Observe correct operation of the power up self test. Check for no immediate alarms and correct display of ambient temperature.

7 Continue to run for at least 30 seconds by which time all the relevant internal tests will have been completed. Switch off.

Twelve Monthly

Execute a performance check appropriate to the humidifier model as detailed in §4.

Carry out Electrical Safety Checks if required (see appendix B2.1).

B2 RECOMMENDED MAINTENANCE SCHEDULE CHECKLIST

(✍ photocopy and complete for each service)

Humidifier Serial Number: _____ Date:_____

	Step	Method	pass ✔	fail ✗
Six Monthly	Perform Temperature Probe Test and Check Temperature Probe	see §4.3 and appendix B	❑	❑
	Check Reusable Heater Wire	see appendix B	❑	❑
	Check Heater Wire Connections	see appendix B	❑	❑
	Check Power Cable	see appendix B	❑	❑
Annually	Performance Check	see §4	❑	❑

B2.1 ELECTRICAL SAFETY TESTS

As required and after any servicing.

	Method	pass ✔	fail ✗
Earth resistance test	Measure the resistance from the earth pin on the mains plug to:		
	i The heaterplate.	❑	❑
	ii The earth stud on the base of the humidifier.	❑	❑
	Should be 0.2 Ω maximum.		
Insulation resistance test	Use a 500V DC tester to measure the resistance from the phase pin on the mains plug to:		
	i The heaterplate (10 MΩ minimum).	❑	❑
	ii The earth stud on the base of the humidifier (10 MΩ minimum).	❑	❑
Earth Leakage test	Has to be measured using an electrical safety tester as per UL544 or IEC601. Measure earth leakage with the earth probe of the tester on the heaterplate. Earth leakage current is measured at normal operating voltage and frequency of supply.		
	Should be 0.5 mA maximum in no fault condition.	❑	❑

Signature:_____

APPENDIX C PROBLEMS WITH OPERATION

C1 TROUBLESHOOTING GUIDE FOR THE HC500 RESPIRATORY HUMIDIFIER

This is a guide to possible corrective action in the case of a humidifier alarm condition or malfunction. It is written for the HC500 humidifier in the heater wire ON mode. Parts of this guide would not be applicable in the heater wire OFF mode. For additional information refer to the operating manual.

Unless the cause and immediate effects of an alarm condition are understood and assessed to be of no hazard to the patient, the humidifier should be immediately switched off and removed from the patient circuit.

C1.1 LOW TEMPERATURE

Condition detected	*Possible cause*	☞*Action to take*
Temperature less than desired, no alarm.	Humidifier warming up.	Wait for a few minutes.
	Temperature probe not in position.	Check position of temperature probe in the circuit.
Airway temperature low alarm activated.	Gas flow stopped or interrupted.	Turn humidifier off until gas flow resumed.
	Temperature probe not in probe housing.	Fit temperature probe.
	Gas flow rate too low.	Increase gas flow to more than 2 litres per minute.
	Too much distance between end of heater wire and temperature probe.	Use longer heater wire or shorten inspiratory hose so that distance is between 25 (1") and 100 mm (4"), ideally 30 mm.
Chamber temperature low alarm activated.	Poor thermal contact between base of chamber and heaterplate.	Check that chamber base and heaterplate are clean, smooth and flat. If necessary clean or replace. Humidification chambers which are not manufactured by Fisher & Paykel may not be suitable.
	Temperature probe not inserted at chamber outlet.	Fit temperature probe correctly.
	Heater element needs replacement.	Send for repair.
	Gas flow rate too high for chamber.	Use correct chamber. Refer to the operating instructions for the type of chamber used.

C.1.2 HIGH TEMPERATURE

Condition detected	*Possible cause*	☞*Action to take*
Airway temperature high alarm activated.	Sudden spurious increase in gas flow.	Wait for temperature to fall below threshold.
	Heater wire too close to temperature probe.	Use shorter heater wire or lengthen inspiratory hose so that distance is between 25 (1") and 100 mm (4"), ideally 30 mm.
Chamber temperature high alarm activated.	Humidification chamber outlet temperature too high.	Remove humidifier from breathing circuit and check humidifier.
	No water in chamber.	Refill humidification chamber.

C.1.3 TEMPERATURE FLUCTUATING

Condition detected	*Possible cause*	☞*Action to take*
High and low temperature alarms.	Ventilation rate too low or too erratic for proper humidifier temperature control.	Ventilation rates below about 6bpm or of a highly erratic nature may affect the stability of the temperature control.
	Humidifier temperature control influenced by external heating or cooling such as air conditioner.	Shield breathing circuit from external influence.
	Temperature probes incorrectly positioned.	Check temperature probe position in the circuit.

C.1.4 EXCESSIVE WATER IN CIRCUIT

Condition detected	*Possible cause*	☞*Action to take*
Accumulation of water visible in circuit.	If in non-heated wire mode, water trap not at the lowest point of the circuit.	Reposition water trap.
	If in heated wire mode, heater wire too close to temperature probe.	Increase distance from heater wire to temperature probe so that the distance is between 25 (1") and 100mm (4"), ideally 30mm.
	Delivery circuits being cooled by air conditioner.	Shield circuit from air conditioner or use heater wire circuits.
	Humidification chamber filled beyond maximum water level line.	Reduce water level.
	Maximum permissible peak flow rate of humidification chamber has been exceeded.	Use correct chamber. Refer to the operating instructions for the type of chamber used.
	Humidifier chamber tilted.	Ensure chamber is level.

C.1.5 LOW HUMIDITY

Condition detected	*Possible cause*	☞*Action to take*
No evidence of humidity.	No water in humidification chamber.	Fill chamber.
	Check chamber temperature via service menu.	If low check heaterplate maximum temperature setting in the service menu and that chamber base and heaterplate are smooth and flat.
	Gas flow rate too high for chamber.	Use correct chamber. Refer to the specific operating instructions for the type of chamber used.
	Non Fisher & Paykel Humidification chambers may be unsuitable.	Use Fisher & Paykel chamber.

C.1.6 CONNECTORS ALARM

Condition detected	*Possible cause*	☞*Action to take*
Temperature probe alarm, '- - -' on temperature display.	Temperature probe unplugged.	Check connection.
	Temperature probe plug dirty.	Clean plug.
	Temperature probe faulty.	Replace temperature probe.
Connectors alarm, display blank.	Heater wire power cord unplugged.	Check connection.
	Heater wire broken.	Replace heater wire.
	Heater wire switch turned off.	But heater wire connected.
	Heater wire switch turned on.	But heater wire not connected.
Connectors alarm, F2 on temperature display.	Internal fuse blown.	Send for repair.
	Calibration incorrect.	Check calibration of the 41 °C comparator.

C.1.7 'POWER-ON' INDICATOR OFF

Condition detected	*Possible cause*	☞*Action to take*
'Power-on' indicator not illuminated.	Humidifier voltage rating incorrect.	Select correct voltage rated unit.
	Humidifier power cord not connected to mains supply.	Connect to mains.
	Humidifier power switch not turned on.	Turn humidifier on.
	Overheat protector operated.	Send for repair.
	Transformer over heat protector operated.	Send for repair. The transformer can be overloaded if the incorrect heater wire is used.

C.1.8 'SEE MANUAL' INDICATOR ON

Condition detected	*Possible cause*	☞*Action to take*
'see manual' indicator illuminated.	Humidifier failed self test.	Send for repair.

C.1.9 BREATHING CIRCUIT LEAK

Condition detected	*Possible cause*	☞*Action to take*
Escaping gas.	Circuit connections not made correctly.	Check all circuit connections, check that humidification chamber water filler stopper is in place or water bag connected. Check that temperature probes are fitted correctly.

C.1.10 ERROR CODE DISPLAYED

Condition detected	*Possible cause*	☞*Action to take*
Error code appears on digital segment display.	Humidifier microprocessor failed self test.	Send for repair.

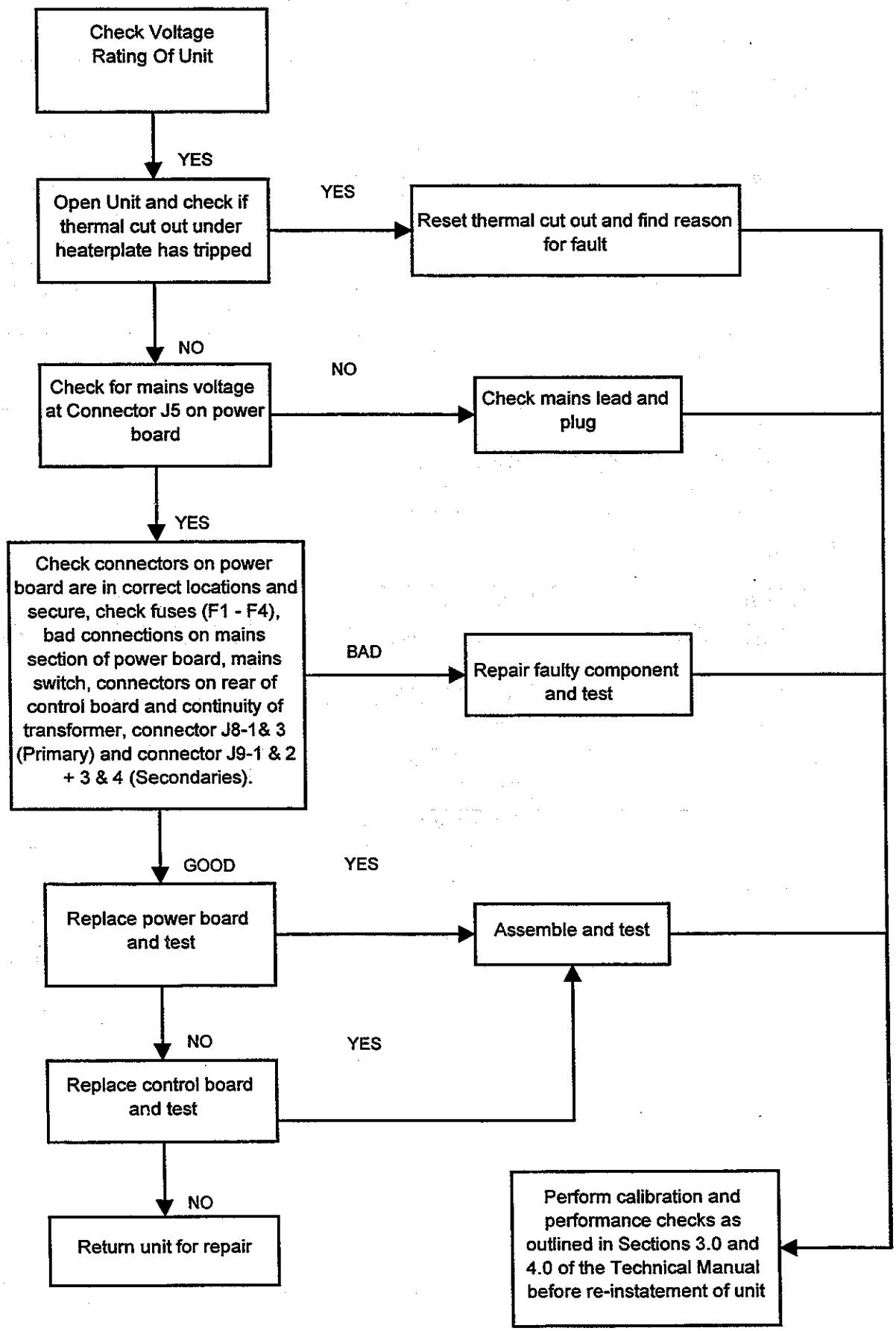
C.1.11 CHAMBER WATER LEAK

Condition detected	*Possible cause*	☞*Action to take*
Wetness on outside of chamber.	Reusable chamber O-ring seal.	Should be clean and correctly fitted.
	Damaged reusable chamber O-ring.	Replace if necessary.
	Disposable chamber in use for too long.	Replace chamber.
	Damage to chamber.	Replace chamber.

C.1.12 NO AUDIBLE SOUND WITH ALARM INDICATOR

Condition detected	*Possible cause*	☞*Action to take*
Inaudible sound with visible alarm indicator.	Mute button pushed.	Wait 3 minutes.

C2 HC500 FAULT FLOW CHART FOR NO GO CONDITION


Check Voltage Rating Of Unit
YES
Open Unit and check if thermal cut out under heaterplate has tripped
YES
Reset thermal cut out and find reason for fault
NO
Check for mains voltage at Connector J5 on power board
NO
Check mains lead and plug
YES
Check connectors on power board are in correct locations and secure, check fuses (F1 - F4), bad connections on mains section of power board, mains switch, connectors on rear of control board and continuity of transformer, connector J8-1& 3 (Primary) and connector J9-1 & 2 + 3 & 4 (Secondaries).
BAD
Repair faulty component and test
GOOD
YES
Replace power board and test
Assemble and test
NO
YES
Replace control board and test
NO
Return unit for repair
Perform calibration and performance checks as outlined in Sections 3.0 and 4.0 of the Technical Manual before re-instatement of unit